

## D.G.E -HR.SEC. EXAMINATION MARCH - 2014

REGISTER NUMBER

606676



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GROUP CODE : 103

SUBJECT : 005 PHYSICS E

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SUB CODE : 005 MEDIUM : E

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(C)

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(B)

## D.G.E -HR.SEC. EXAMINATION MARCH - 2014

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BUNDLE NO

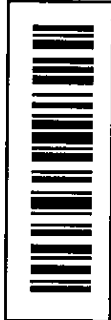
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SUBJECT :

005 PHYSICS E



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Marks in Words

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Stitching Line





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அகத் தேர்வுகள் துறை  
DEPARTMENT OF GOVERNMENT EXAMINATIONS

Script No. 04

Total Marks

1 4 9

HSE

வினாத்தாள் திருத்துவோர் நிறைவு செய்ய வேண்டியவை

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வினாவாரியாக மொத்தம் Questionwise Total										பக்கவாரியாக மொத்தம் Pagewise Total			
வினா எண் Q.No	மதிப் பெண்கள் Marks	வினா எண் Q.No	மதிப் பெண்கள் Marks	வினா எண் Q.No	மதிப் பெண்கள் Marks	வினா எண் Q.No	மதிப் பெண்கள் Marks	வினா எண் Q.No	மதிப் பெண்கள் Marks	பக்க எண் Page No	மதிப் பெண்கள் Marks	பக்க எண் Page No	மதிப் பெண்கள் Marks
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வினாவாரியாக ஒட்டு மொத்தம்  
Question-wise Grand Total

1482

149

பக்கவாரியாக மொத்தம்  
Page-wise Total

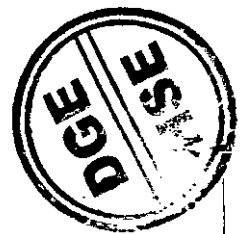
1482

149

தேர்வு எழுதுபவர் செய்யக்கூடியவை மற்றும் செய்யக்கூடாதவை

### Do's & Don'ts for Candidates

- |   |  |
|---|--|
| <p>1. முகப்புச்சீட்டில் உரிய இடத்தில் கையொப்பமிட வேண்டும்.<br/>Put your signature in the Top sheet in the appropriate place.</p>                          | <p>1. வினாத்தாளில் எந்தவித குறியீடும் இடக்கூடாது.<br/>No marking in the question paper.</p>  |
| <p>2. விடைத்தாளில் ஒரு பக்கத்திற்கு 20 முதல் 25 வரிகள் வரை எழுதவேண்டும்.<br/>Write 20 to 25 lines in a page.</p>  | <p>2. விடைத்தாளை சேதப்படுத்தக் கூடாது.<br/>Don't damage the answer paper.</p>  |
| <p>3. விடைத்தாளின் இருபுறத்திலும் எழுத வேண்டும்.<br/>Write answers in both sides of paper.</p>  | <p>3. விடைத்தாளில் எந்த ஒரு பக்கத்திலும் தேர்வு எண்/பெயர் எழுதக்கூடாது.<br/>Don't write name / Register Number in any page of the answer book.</p> |
| <p>4. செய்முறைகள் யாவும் விடைத்தாளின் கீழ் பகுதியில் இடம் பெறவேண்டும்.<br/>All rough works must be done on the lower part of the page.</p>                | <p>4. வண்ணக்கலர் கொண்ட பேனா/ பென்சில் எதையும் பயன்படுத்தக் கூடாது.<br/>Don't write with sketch colour pencils.</p>                                 |
| <p>5. வினா எண் தவறாமல் எழுத வேண்டும்.<br/>Write the question numbers without fail.</p>  | <p>5. விடைத்தாள் கோட்டின் இடது பக்கத்தில் எழுதக்கூடாது.<br/>Don't write on the margin.</p>   |
| <p>6. இரு விடைகளுக்கிடையே இடைவெளி விட்டு எழுத வேண்டும்.<br/>Leave space between two answers.</p>  | <p>6. விடைத்தாள் புத்தகத்தின் எந்த தாளையும் கிழிக்கவோ/நீக்கவோ கூடாது.<br/>Don't tare / remove any page from the answer book.</p>                   |
| <p>7. வினாத்தாளின் வரிசை (A or B) எழுத வேண்டும்.<br/>Write the question paper booklet series. (A or B)</p>  |  |
| <p>8. விடைத்தாளில் நீலம்/கருப்புமை கொண்ட பேனாவால் விடைகளை தெளிவாக எழுத வேண்டும்.<br/>Answers must be legibly written either in Blue or Black ink pen.</p> |  |
| <p>9. விடைத்தாளில் எழுதாத பக்கங்களில் குறுக்குக்கோடு இடவேண்டும்.<br/>Cross the unwritten pages.</p>   |  |



# PART - I

1. a)  $\frac{1}{r^2}$
2. c)  $\frac{\sigma}{\epsilon_0}$
3. b)  $\frac{q}{4} \sqrt{k}$  metre
4. a)  $2 \times 10^{-9} \text{ N}$
5. b)  $x^2 = 1$
6. a)  $\pi \times 10^{-5} \text{ T}$
7. c) high specific resistance
8. b)  $0.25 \text{ H}$
9. a) AC only
10. b) Room heater

$$\frac{n R n}{R}$$

$$\frac{\mu_0 n I}{2a}$$

GEX. 54-1A

$$F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$$

$$\frac{R}{n} 16 = \frac{9 \times 10^9 \times -q^2}{r^2}$$

$$4\pi \times 10^{-7} \times \frac{2 \times 10^3 \times 10^2}{16} = \frac{9 \times 10^9 \times -q^2}{16}$$

$$\pi \times 10^{-5} \times 2 \times 10^5 = \frac{2 \times 10^3 q}{4}$$

$$F = \frac{E}{q_0}$$

$$F = 10 \times 2 \times 10^{-10}$$

$$L = \frac{-e}{\frac{\partial I}{\partial t}} = \frac{-25}{100}$$

$$F = k \frac{q_1 q_2}{r^2} \quad r^2 = \frac{k q_1 q_2}{F} = \frac{9 \times 10^9 \times 2 \times 10^{-7}}{10} = \frac{18 \times 10^2}{10} = 180$$

11. a) the average value of current is zero
12. b) power is transmitted in a direction perpendicular to both the fields.
13. ~~a) contracts~~ a) pure line spectrum
14. a) contracts
15. d) Apary
16. b) absorbs green light
17. a) a stream of electrons
18. c) phase and amplitude
19. ~~b)~~ 10.2 eV
20. a)  $\lambda = \frac{h}{\sqrt{2mE}}$

21. a) ~~zero~~
22. d)  ~~$Na^{24}$~~
23. c) ~~isotopes~~
24. b) ~~mean~~ life
25. c) ~~931 MeV~~
26. d) ~~type of semiconductor material~~
27. b) ~~2.0V~~
28. a) ~~A~~
29. c) ~~spherical~~ propagation.
30. b) ~~twice~~ the signal frequency.

2.7  
0.7

## PART - II

31. Electric dipole moment :

Electric dipole moment is defined as the product of magnitude of one of the charges and the distance between charges.

$$p = q \times 2d$$

$$p = 2qd$$

$p$  - dipole moment

Its acts from  $-q$  to  $+q$

Its is a vector quantity.

Unit : Cm

32) Given :

$$q = 4 \times 10^{-7} \text{ C}$$

$$r = 0.09 \text{ m}$$

Formula :

$$V = \frac{1}{4\pi\epsilon_0} \frac{q}{r}$$

$$= \frac{9 \times 10^9 \times 4 \times 10^{-7}}{0.09} = \frac{36 \times 10^2}{9 \times 10^2} = 4 \text{ V}$$

$$\begin{aligned} & \frac{36 \times 10^2 \times 10^{-2}}{9} \\ & \frac{36 \times 10^2}{9 \times 10^2} \\ & \frac{9 \times 10^9 \times 4 \times 10^{-7}}{9 \times 10^2} \end{aligned}$$



33.

changes observed at Transition temperature:

- (i) The electrical resistivity becomes zero.
- (ii) The conductivity becomes infinity.
- (iii) The magnetic flux lines are excluded from the material.

34.

Kirchoff's Voltage law:

Kirchoff's voltage law states that the algebraic sum of product of current and resistance in each part of any closed circuit is equal to the algebraic sum of the emfs present in that closed circuit.

This law is a consequence of conservation of energy.

35.

2

Given :

$$V = 240 \text{ V}$$

$$I = 0.5 \text{ A}$$

$$R = ?$$

Formula,

By Ohm's law

$$V = IR$$

$$R = \frac{V}{I}$$

$$R = \frac{240}{0.5}$$

$$= \frac{2400}{5} = \underline{\underline{480 \Omega}}$$

$$\begin{array}{r} 2400 \\ 5 \\ \hline = 8480 \end{array}$$

$$\begin{array}{r} 2400 \\ 5 \\ \hline = 480 \end{array}$$

Ans: Resistance = 480  $\Omega$ 

36.

2

Peltier coefficient ( $\pi$ )

The amount of heat energy absorbed or evolved in any one of the junctions when unit current flows in the circuit for one second (1 coulomb) is

called Peltier coefficient.

$$\Pi = V I t$$

Its unit is volt.

It depends on the temperature of the junctions.

37. Lenz law :

Lenz law states that the induced current produced in a circuit always flows in such a direction that it opposes the change or cause that produces it.

This is a consequence of conservation of energy.

$$\epsilon = - \frac{d\phi}{dt} = - \frac{d(NBA)}{dt} = -NA \frac{dB}{dt}$$

38.

Given:

$$N = 200$$

$$A = 0.04 \text{ m}^2$$

$$\phi_1 = 0.1 \text{ Wb m}^{-2}$$

$$\phi_2 = 0.04 \text{ Wb m}^{-2}$$

$$t = 0.02$$

$$e = ?$$

Soln:

$$e = - \frac{d(NAB)}{dt}$$

$$= -NA \left( \frac{dB}{dt} \right)$$

$$= -NA \frac{(\phi_2 - \phi_1)}{t}$$

$$= -200 \times 0.04 \times \frac{(0.04 - 0.1)}{0.02}$$

$$= -200 \times 0.04 \times \frac{-0.06}{0.02}$$

$$= \frac{200 \times 0.04 \times 0.06}{0.02}$$

$$= \underline{\underline{24 \text{ V}}}$$

$$\begin{array}{r} 0.04 \\ 0.1 \\ \hline 0.06 \end{array}$$

860

$$\frac{200 \times 0.04 \times 0.06}{0.02}$$

$$8 \times 3 = 24$$

40. Conditions for Total Internal Reflections :-

- (i) The light must travel from denser medium to rarer medium.
- (ii) The angle of incidence ( $i$ ) inside the denser medium should be greater than the critical angle ( $c$ )

$$i > c$$

41.

Soft x-rays

Hard x-rays

- (i) They have wavelength of upto  $4 \text{ \AA}$ .
- (ii) They have low penetrating power and hence called soft x-rays.
- (iii) They have low energy, low frequency and produced at low potential difference

They have wavelength of  $1 \text{ \AA}$  or below.

They have high penetrating power.

They have high energy, high frequency and produced at high potential difference comparatively.



42.

Given :

$$E = 3.4 \times 10^4 \text{ V/m.}$$

$$B = 2 \times 10^{-3} \text{ T.}$$

$$V = ?$$

Soln :

$$B \times V = E \times c$$

$$V = \frac{E}{B}$$

$$V = \frac{3.4 \times 10^4}{2 \times 10^{-3}}$$

$$V = 1.7 \times 10^7 \text{ m/s}$$

$$\frac{3.4}{2} = 1.7$$

43.

Applications of photoelectric cells :

(i) They are used in automatic switching on and off of street lights.

(ii) They are used in automatic opening and closing of doors.

(iii) They are used to study the temperature and spectra of stars.

44. Properties of  $n^0$ :

- 2 (i) They are the basic constituents of all atoms except hydrogen atom.
- (ii) As they are neutral, they can penetrate easily inside any nucleus.
- (iii) They do not have any charge, mass slightly greater than that of protons. They are not deflected by electric and magnetic fields.

47. Advantages of IC:

- (i) Extremely small in size
- (ii) very small weight
- (iii) Low cost
- (iv) Easy replacement
- (v) Reliability
- (vi) High efficiency

45. Pair production:

2 The phenomenon by which high energy photon produces electron positron pair in a electric field surrounding the nucleus is called pair production.

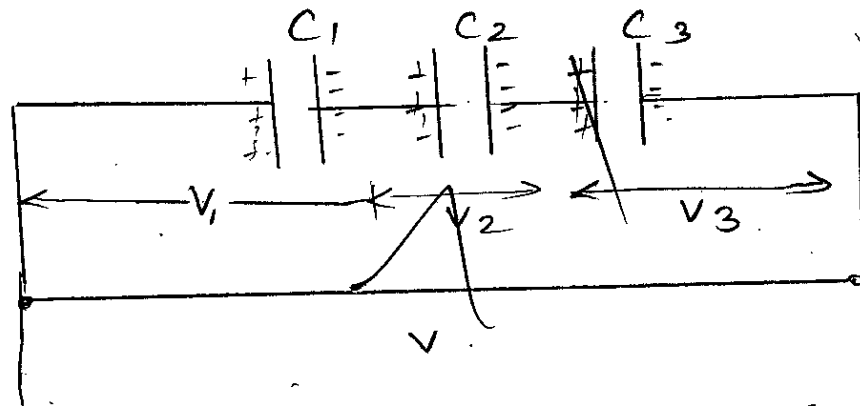
The reversal of pair production in which electron positron pair combine to form a photon is called annihilation of matter.

50. Skip distance:

2 In sky wave propagation, for a given frequency, the shortest distance between the point of transmission and point of reception is called skip distance.



## PART - III

Capacitance in series :

Let us consider three capacitors of capacitances  $C_1$ ,  $C_2$ ,  $C_3$  connected in series.

A potential of ' $V$ ' is connected across the capacitors.

When the capacitors are connected in series, the charge flowing through each capacitor is the same.

The voltage flowing through  $C_1$ ,  $C_2$ ,  $C_3$  be  $V_1$ ,  $V_2$ ,  $V_3$  respectively.

$$V_1 = \frac{q}{C_1}, \quad V_2 = \frac{q}{C_2}, \quad V_3 = \frac{q}{C_3}$$

$$V = V_1 + V_2 + V_3$$

$$V = \frac{q}{C_1} + \frac{q}{C_2} + \frac{q}{C_3}$$

$$V = q \left[ \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \right] \rightarrow \textcircled{1}$$

Let  $C_s$  be the effective capacitance connected in series when a voltage of 'V' is produced when given a charge 'q'.

$$V = \frac{q}{C_s} \rightarrow \textcircled{2}$$

Sub  $\textcircled{2}$  in  $\textcircled{1}$

$$\frac{q}{C_s} = q \left[ \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \right]$$

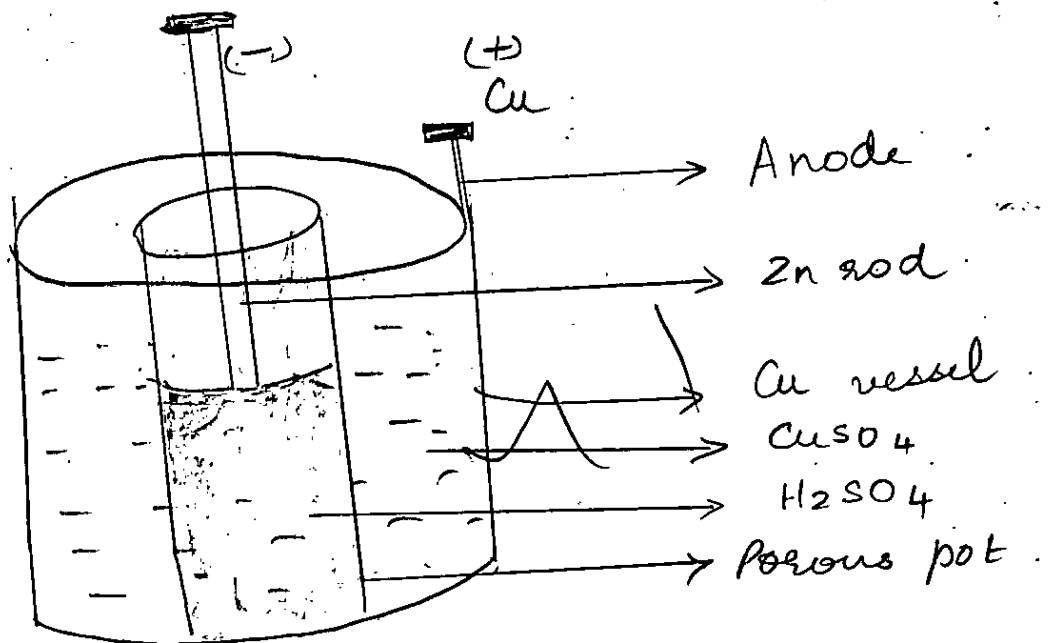
$$\boxed{\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$

The effective capacitance of the capacitances is given by the relation.

$$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

The reciprocal of the effective capacitance of the series combination is equal to the sum of the reciprocals of the capacitances of individual capacitors.

## 52. Daniel Cell :





## Construction

- (i) Daniel cell is one of the primary cell and does not give current for a long time.
- (ii) It consists of a copper vessel which acts as anode.
- (iii) A porous pot which contains zinc rod dipped in  $H_2SO_4$  is kept inside the glass vessel which acts as cathode (zinc).
- (iii) The glass vessel contains  $CuSO_4$  which is electrolyte.

## Working

- At Zn rod, Zn dissolves in  $H_2SO_4$  producing  $Zn^{++}$  and 2 electrons

Qm

- 2) The two electrons remain at the zinc electrode making it negative.
- 3) The  $Zn^{++}$  pass through the porous pot and react with  $CuSO_4$  producing  $Cu^{++}$  ions.
- 4)  $Cu^{++}$  ions get deposited at the anode thus making it positive.
- 5) When they are connected in external circuit, the current flows from Cu to Zn.
- 6) The two electrons from Zn rod continuously move from Zn to Cu vessel. this makes the conventional current to flow in opposite direction.
- 7) The emf produced in the cell is about 1.08 volts.



54.

Given:

$$I = 4 \text{ A}$$

$$N = 5$$

$$d = 30 \text{ cm}$$

$$a = \frac{30}{2} \times 10^{-2} = 15 \times 10^{-2} \text{ m}$$

$$B_H = 4 \times 10^{-5} \text{ T}$$

$$\theta = ?$$

Formula:

$$I = \frac{2a B_H \tan \theta}{\mu_0 n}$$

$$\tan \theta = \frac{\mu_0 n I}{2a B_H}$$

$$= \frac{4\pi \times 10^{-7} \times 5 \times 4^2}{2 \times 15 \times 10^{-2} \times 4 \times 10^{-5}}$$

$$= \frac{3.14 \times 5 \times 10^{-7} \times 10^{-7} \times 2}{15}$$

$$\tan \theta = 2.093$$

$$\theta = \tan^{-1}(2.093)$$

$$\theta = 64^\circ 28'$$

$$\frac{31.4}{15}$$

$$\begin{array}{r} 15 \overline{) 31.4} \\ 30 \phantom{0} \\ \hline 140 \\ 135 \\ \hline 50 \end{array}$$

$$\frac{50}{25}$$

55 Self Inductance of long solenoid:

Let us consider a solenoid of length 'l', area of cross section 'A', carrying a current  $I$ . Let 'n' be the number of turns.

Magnetic field inside a solenoid of n turns is  $B = \mu_0 \frac{NI}{l}$  ✓

Magnetic flux per turn of the solenoid =  $B \times \text{Area of each turn}$

$$= B \times A$$

$$= \frac{\mu_0 NI}{l} \times A$$
 ✓

The total magnetic flux ( $\phi$ ) through

the solenoid = Magnetic flux per turn  $\times$  Number of turns of solenoid

$$\phi = BA \times N$$
 ✓

$$\phi = \frac{\mu_0 NI}{l} A \times N$$

$$\boxed{\phi = \frac{\mu_0 N^2 I A}{l}}$$
 ✓

①

3

But, we know that,

$$\boxed{\phi = LI} \rightarrow \textcircled{2}$$

$L$  is the self inductance of solenoid

Equating ① & ②.

$$LI = \frac{\mu_0 N^2 I A}{l}$$

$$\boxed{L = \frac{\mu_0 N^2 A}{l}}$$

If the solenoid is placed in a medium of permeability  $\mu$ , then,

$$\boxed{L = \frac{\mu N^2 A}{l}}$$



## 57. Properties of canal rays :

- 5 (i) They are streams of positive ions of the gas present in the discharge tube. They have properties opposite to that of cathode rays. Their direction of deflection is opposite to cathode rays. 5
- (ii) Their velocity is less than the cathode rays.
- (iii) They produce fluorescence.
- (iv) They affect photographic plates.
- (v) They ionise the gas through which they pass. 5



58.

Einstein's photoelectric equation:

In 1905, Einstein studied a relationship between photoelectric current with quantum theory of light.

According to him, when a photon of energy  $h\nu$ , is incident on a metal plate, the energy is used up in two ways.

- (i) A part of the energy of photon is used to remove an photoelectron from the metal surface. The electrons are tightly held to the nucleus. This energy required is called work function ( $\phi$ ) of the material.

Qn

Work function is defined as the minimum energy required to liberate a electron from the metal surface. This is characteristic of the metal.

- (ii) The remaining part of the energy is used to impart kinetic energy to the liberated electron.

$$\text{Energy of photon} = \text{Work function} + \text{Kinetic energy of the photon.}$$

Maximum Kinetic energy:

If the liberated photon does not lose energy by collisions, then the remaining energy ( $h\nu - w$ ) will be converted to kinetic energy. If  $v_{\text{max}}$  is the maximum velocity of the liberated electron then,

$$h\nu = w + \frac{1}{2} m v_{\text{max}}^2$$

*Dr*

Zero kinetic energy :

When the liberated electron loses its energy by collision and also if the photon is incident at threshold frequency ( $\nu_0$ ), the velocity of photoelectron liberated will be zero.

$$W = h\nu_0$$

{ since kinetic energy of photoelectron is zero }

If  $\nu$ , is the velocity of photoelectron then,

$$h\nu = h\nu_0 + \frac{1}{2}mv_{\max}^2$$

$$h(\nu - \nu_0) = \frac{1}{2}mv_{\max}^2$$

This is called Einstein's photoelectric equation.

60) Given:

$$\text{Energy} = 32 \times 10^6 \text{ W}$$

$$\text{Energy per fission} = 200 \text{ MeV}$$

$$\text{No. of fissions} = ?$$

Soln:

$$\begin{aligned} \text{Energy per fission} &= 200 \text{ MeV} \\ &= 200 \times 10^6 \times 1.6 \times 10^{-19} \text{ J} \end{aligned}$$

$$\begin{aligned} \text{Energy per fission} \times \text{Number of fission} \\ &= \text{Energy liberated} \end{aligned}$$

$$\begin{aligned} \text{Number of fissions} &= \frac{\text{Energy developed in reactor}}{\text{Energy per fission}} \end{aligned}$$

$$= \frac{32 \times 10^6 \text{ J/s}}{200 \times 10^6 \times 1.6 \times 10^{-19} \text{ J}}$$

$$= \frac{32 \times 10^6}{32 \times 10 \times 10^6 \times 10^{-19}} \text{ /sec}$$

$$= 10^{-1} \times 10^{19} \text{ /sec}$$

$$N = 10^{18} \text{ fissions/sec}$$

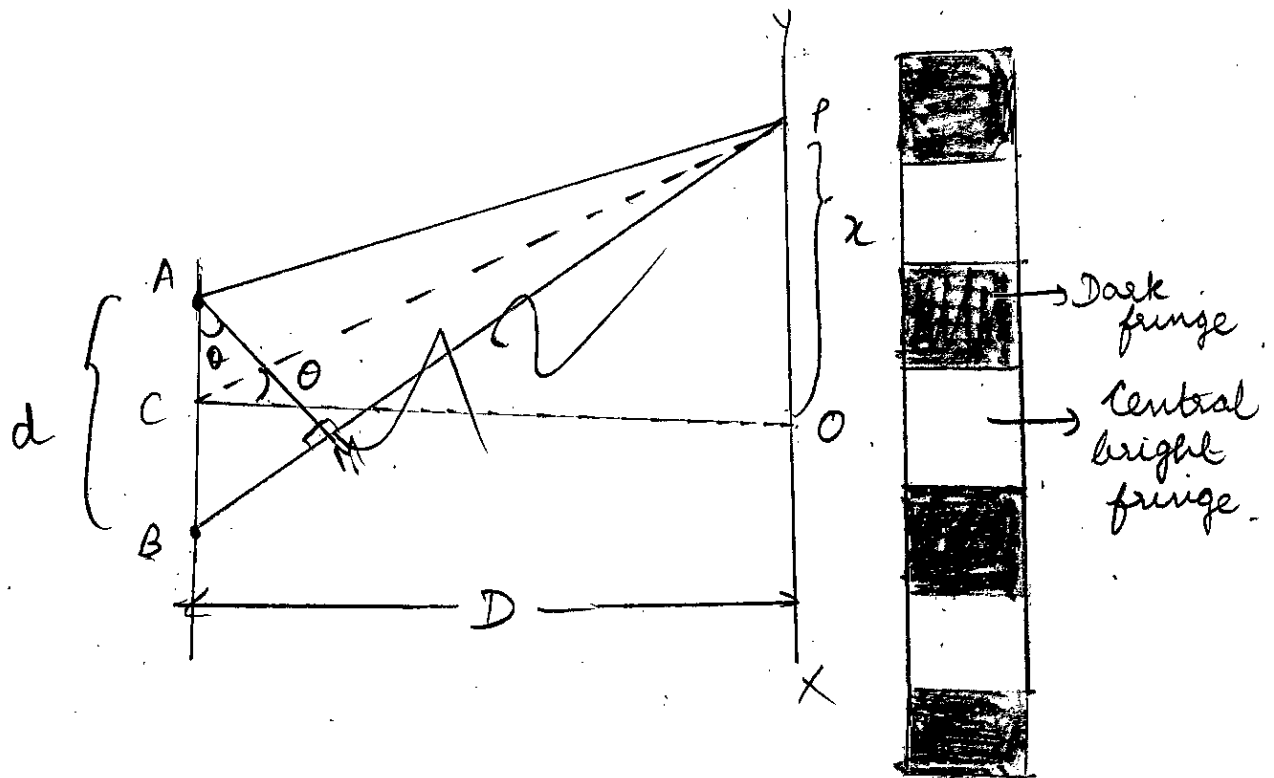
$$\text{Number of fissions} = \frac{1 \times 10^{18} \text{ fission/sec}}{\text{second}}$$

## PART - IV.

66.

20

Young's double slit experiment :



1) Let us consider two coherent sources A, B separated by a distance ' $d$ ' light of wavelength  $\lambda$ . Let C be the mid point of the sources A & B. Let XY be the screen placed at a distance ' $D$ ' from the sources. Let 'O' be the point of XY which is equidistant from C.

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(i) Let  $P$  be a point on the screen at a distance ' $x$ ' from ' $O$ '.

(ii) The fringes at  $P$  depend upon the path difference between the waves  $AP$  and  $BP$  which produce the fringe.

To find the path difference:

The path difference between the waves  $AP$  and  $BP$  is  $\delta$ .

$$\delta = BP - AP$$

Let  $AM \perp$  drawn to  $BP$  at  $M$ .

$$\therefore AP = MP$$

$$\delta = BP - AP = BP - MP = \underline{BM}$$

$$\boxed{\delta = BM} \rightarrow \text{①}$$

In  $\triangle ABM$ .

$$\sin \theta = \frac{BM}{AB} = \frac{BM}{d}$$

$$\boxed{BM = d \sin \theta}$$

If ' $\theta$ ' is very small,  
then  $\sin \theta = \theta$ .

$$\boxed{BM = d \cdot \theta} \rightarrow (2)$$

In  $\triangle COP$ .

$$\tan \theta = \frac{OP}{CO} = \frac{x}{D}$$

If  $\theta$  is small.

$$\tan \theta = \theta$$

$$\boxed{\theta = \frac{x}{D}} \rightarrow (3)$$

Sub. (2) & (3) in (1),

$$\boxed{\delta = \frac{x d}{D}}$$

Bright fringes:

The condition to produce bright fringes is path difference should be  $n\lambda$ .

$$\frac{x d}{D} = n\lambda$$



$$x = \frac{D n \lambda}{d}$$

where  $n = 0, 1, 2, 3, \dots$  order of bright fringes.

Bright fringes are produced at a distance  $x$  from 0 corresponding to  $n = 1, 2, 3$ .

Dark fringes:

The condition for dark fringes to occur is path difference  $= (2n-1)\lambda/2$ .

$$x \frac{d}{D} = (2n-1)\lambda/2$$

$$x = \frac{D (2n-1) \lambda}{2d}$$

where  $n = 1, 2, 3, \dots$

Dark fringes occur at a distance  $x$  corresponding to  $n = 1, 2, 3, \dots$  above the central bright fringe.

Thus alternate dark and bright fringes above the central bright fringe.

## Bandwidth

Bandwidth is defined as the distance between two adjacent ~~dark~~ fringes or bright fringes.

For, two bright fringes,  $x_{n+1}$ ,  $x_n$ , the bandwidth is given by:

$$x_{n+1} - x_n = \frac{D}{d}(n+1)\lambda - \frac{D}{d}n\lambda$$

$$\boxed{\beta = \frac{D}{d}\lambda}$$

For dark fringes, also the same bandwidth is obtained.

above the central bright fringe, alternate dark and bright fringes appear.

$\beta$  can be increased by

- (i) increasing the distance between source and screen.
- (ii) increasing wavelength of light.
- (iii) decreasing the distance between the two slits.

67) Postulates of Bohr model:

Bohr modified Rutherford's model, in order to explain the stability of the atom.

- (i) An electron does not revolve around the nucleus in all possible orbits. An electron revolves around the nucleus only in certain permitted orbits in which the angular momentum of an electron is an integral multiple of  $\frac{h}{2\pi}$ .

( $h$  is Planck's constant

$$= 6.626 \times 10^{-34} \text{ Js})$$

In this orbit, the electron does not radiate energy. Hence these energy levels are called stationary levels (or) stationary orbits.

If 'm', 'v' is mass and velocity of electron in ~~permitted~~ orbit of radius 'r', then the angular momentum of the electron is an integral multiple of  $\frac{h}{2\pi}$ .

$$mvr = \frac{nh}{2\pi}$$

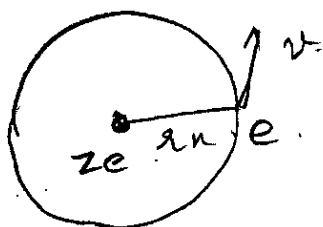
where  $n = 1, 2, 3, \dots$  principle quantum number.

This is called Bohr's quantisation condition.

2) An electron emits or radiates energy only when it jumps from higher energy state to lower energy state. If an electron jumps from  $E_2$  (higher) to  $E_1$  (lower), then it radiates energy  $h\nu = E_2 - E_1$ .

This condition is called Bohr's frequency condition.

Radius of  $n^{\text{th}}$  orbit :



Let us consider the atom having nuclear charge  $Ze$  and an electron revolving around the nucleus in a circular orbit of radius  $r_n$ .

The nuclear charge is  $Ze$  where ' $Z$ ' is atomic number equal to number of protons which is here equal to number of electrons.

The electrostatic force of attraction between the nucleus and the electron revolving in the orbit is

$$F = \frac{1}{4\pi\epsilon_0} \frac{(Ze) e}{r_n^2} \rightarrow (1)$$

This force provides the necessary centripetal force for the electron revolving around the nucleus.

$$F = \frac{mv^2}{r_n} \rightarrow (2)$$

$v \rightarrow$  velocity of  $e$  in  $n^{\text{th}}$  orbit

Electrostatic force provides the necessary centripetal force.

$$\frac{1}{4\pi\epsilon_0} \frac{Ze^2}{r_n^2} = \frac{mv_n^2}{r_n} \rightarrow (3)$$

$$\frac{1}{4\pi\epsilon_0} \frac{Ze^2}{r_n^2} = \frac{m r_n^2 \omega_n^2}{r_n} \quad \left( \text{since } v_n = r_n \omega_n \right)$$

$$\omega_n^2 = \frac{1}{4\pi\epsilon_0} \frac{Ze^2}{m r_n^3} \rightarrow \textcircled{4}$$

By Bohr's first postulate,

$$L = \frac{n h}{2\pi} \rightarrow \textcircled{5}$$

By, angular momentum of an electron

$$L = m v r \rightarrow \textcircled{6}$$

Equating  $\textcircled{5}$  &  $\textcircled{6}$

$$\frac{n h}{2\pi} = m v_n r_n$$

$$m r_n^2 \omega_n = \frac{n h}{2\pi} \quad \left( \text{since } v_n = r_n \omega_n \right)$$

$$\omega_n = \frac{n h}{2\pi m r_n^2}$$

$$\omega_n^2 = \frac{n^2 h^2}{4\pi^2 m^2 r_n^4} \rightarrow \textcircled{7} \quad (\text{squaring})$$

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Equating ④ & ⑦.

$$\frac{1}{4\pi\epsilon_0} \frac{ze^2}{m r_n^3} = \frac{n^2 h^2}{4\pi^2 m^2 r_n^4}$$

$$r_n = \frac{n^2 h^2 \epsilon_0}{\pi m z e^2}$$

∴ The radius of  $n^{\text{th}}$  orbit is proportional to the square of principle quantum number.

$$[r_n \propto n^2]$$

Thus, the radius of 1<sup>st</sup> 3 orbits are in the ratio 1 : 4 : 9.

For hydrogen atom  $z = 1$ .

$$r_n = \frac{n^2 h^2 \epsilon_0}{\pi m e^2}$$

For,  $n = 1$ ,

$$r_n = \frac{n^2 h^2 \epsilon_0}{\pi m e^2}$$



Substituting the known values,

For  $n=1$ ,

$$r_n = n^2 \times 0.53 \text{ \AA}$$

$$\therefore r_n = n^2 \times 0.53 \text{ \AA}$$

For  $n=1$ ,

$$[r_1 = 0.53 \text{ \AA}]$$

This is called Bohr's radius.

68) Bainbridge Mass Spectrometer:

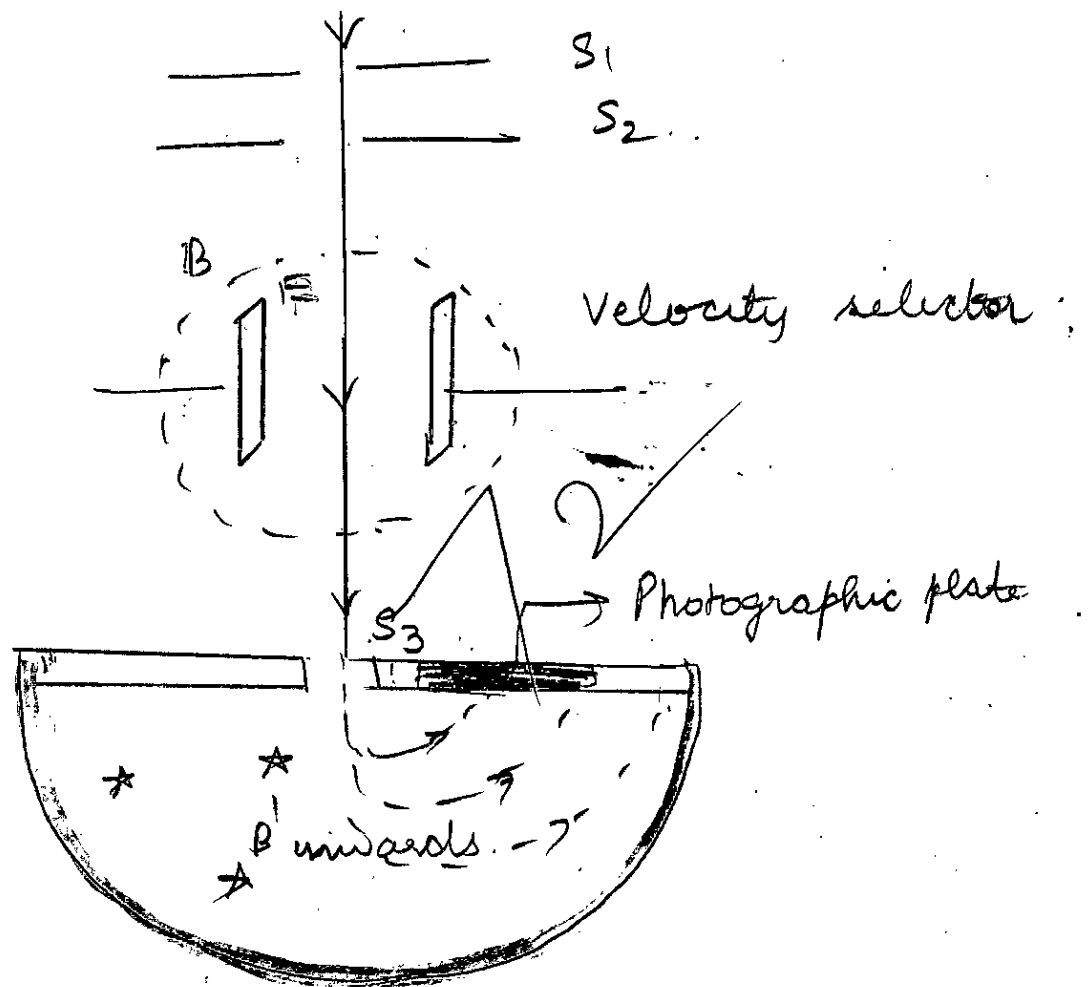
↳ Function:

The Bainbridge Mass spectrometer is an instrument used to measure the isotopic masses.

Principle:

The fact that charged particles are deflected by both electric and magnetic field is the principle used here.

Diagram :



Construction :

- (i) An atom in which two or more electrons removed gains a net positive charge.
- (ii) The positive ions from the discharge tube are passed through two narrow slits  $S_1$  and  $S_2$  and pass through velocity selector.

அரசுத் தேர்வுகள்

கூடுதல் வினா-த்தாள்

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- (iii) The velocity selector allows ions of only particular velocity to pass through it.
- (iv) It consists of two parallel metal plates  $P_1$  &  $P_2$  which produce uniform electric field and electromagnet which produces uniform magnetic field.
- (v) Ions of only particular velocity come out of velocity selector.

Determination of velocity :

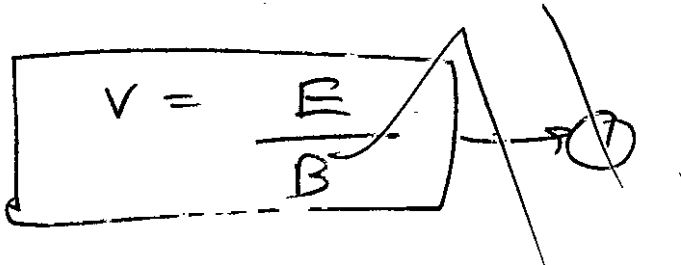
- (1) The force exerted by electric and magnetic field is adjusted so that, the liberated positive charges do not suffer any deviation.

The force exerted by electric field  $E$  on  $q$  is  $Eq$   $\rightarrow$  'q' is velocity of charge of ions

The force exerted by magnetic field is  $Bqv$

$v$  - velocity of ions

$$Eq = Bqv$$

$$\Rightarrow v = \frac{E}{B}$$


### Determination of isotopic masses

The ions of particular velocity are passed through narrow slit  $S_3$  into an evacuated chamber D.

The ions are subjected to another magnetic induction  $B'$  acting inwards  $\perp$  to plane of paper.

The ions traverse a circular path and strike the photographic plate.

The centripetal force is provided by the magnetic field.

$$B'q v = \frac{m v^2}{r}$$

$$m = \frac{B' q r}{v} \quad \left( \text{since } v = \frac{E}{B} \right)$$

$$m = \frac{B B' q R}{E}$$

Conclusion :

Ions of different velocity traverse circular path of different radii and strike the photographic plate.

The distance between the slit  $S_3$  and point of striking gives diameter from which radius can be calculated.

From  $B, B', q, R, E$ , the mass of isotopes can be calculated.

3

69) Rectification :

Q2 ✓ The process of converting alternating input voltage or current into direct voltage or current is called rectification. The device is called rectifier.

Rectifier offers low resistance and PN diode allows current to flow in forward biased condition. This is the principle used here.

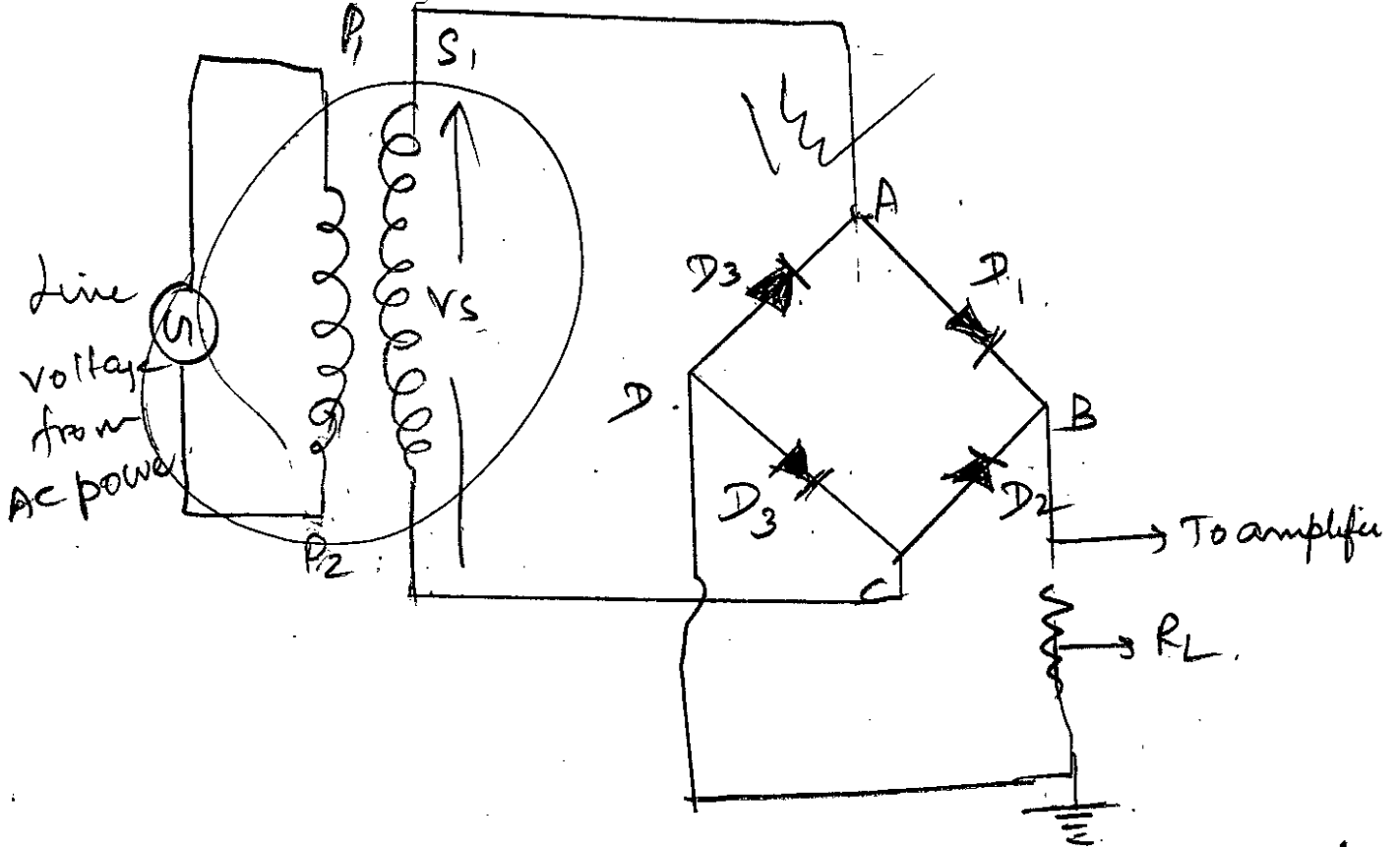
Bridge rectifier :

Bridge rectifier consists of four diodes  $D_1, D_2, D_3, D_4$  connected to form a network.

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Diagram :

The junctions ~~B~~ and ~~B~~ are connected to output through Load Resistor  $R_L$ .

The ~~A~~ and ~~C~~ are connected to secondary ends  $S_1$  &  $S_2$  of transformer

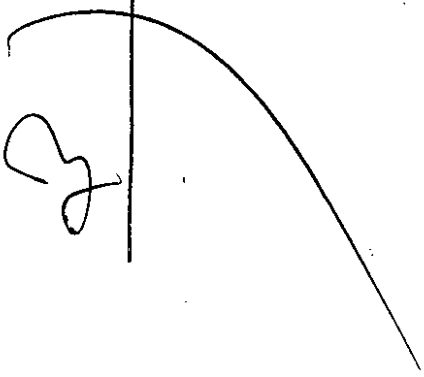
During +ve half cycle:

During +ve half cycle of input AC voltage, diodes,  $D_1$  &  $D_3$  are forward biased. Hence they conduct. The current flows through them  $S_1$  ABDC  $S_3$  through R.

During -ve half cycle :

During -ve half cycle of input AC voltage, diodes  $D_2$  and  $D_4$  are forward biased and hence conduct.  $D_3$  &  $D_1$  are reverse biased and hence do not conduct.

The current flows across the them,  $S_2$  CBDA  $S_1$  through R.





During both the half cycles, output the current flows in the same direction.

The output voltage flows in the same direction for both the half cycles.

Thus DC current is obtained.

### Efficiency

The efficiency of bridge rectifier is 81.2%.

